B.TECH SEM – VIII (2007 COURSE) (CHEMICAL ENGG.)
: WINTER - 2017

SUBJECT: PROCESS EQUIPMENT DESIGN

Day : **Thursday** Time : **02.30 PM TO 05.30 PM**
Date : **23/11/2017** **W-2017-2647** Max. Marks : 80

N. B. :

1) **Q. No. 1** and **Q. No. 5** are **COMPULSORY**. Out of remaining, attempt **ANY TWO** questions from each section.
2) Figures to the right indicate **FULL** marks.
3) Answers to both the sections should be written in **SEPARATE** answer books.
4) Draw neat and labeled diagrams **WHEREVER** necessary.
5) Use of non programmable calculator is allowed.
6) Assume suitable data, if necessary.

SECTION – I

Q. 1 **a)** Draw schematic of H.E. showing all details of sheer side tube side, channels, gasket, flanges, inlets and outlet. **(05)**

b) What are different types of heating and cooling arrangements provided to chemical reactor? **(05)**

c) How does power requirement vary with laminar and turbulent region in agitator? **(04)**

Q. 2 5000 kg/hr of methanol vapours at two atm to be condensed by cooling water available at 10,000 kg/hr, 28^0C. Assuming heat transfer coefficient on methanol vapor side to be 4,500 Wm^2k. Find overall heat transfer coefficient, shell diameter giving tube pitch, baffle spacing? **(13)**
Available pipe ID is 16 mm, 20 mm OD with 16 ft. length.
$U = 600 W/m^2$

Methanol	P (atm)	1	2	3	4	5
	T (^{0}C)	64	78	34	92	99

Q. 3 Six blade pitch blade turbine to be used to make fluorspar slurry in water @ 50^0C. Viscosity of solution is 4 Pa.s, sp. gr.2.05. Diameter of vassel is 1.88 m. Agitator would be run at 20, 80, 200 rpm. **(13)**

i) Find out power requirement for all three speeds.
ii) Suggest best rpm to operate with, logical reasoning.
iii) If above system has to be used for mixing fluid of 4 C_p viscosity and sp. gr. of 1.4. What would be power requirement? If agitator turns @ 120 rpm.

P. T. O.

Q.4 Biodiesel to be produced in a reactor with plain jacket for heating of reactor content. Suggest efficient design of shell jacket using following data: **(13)**

Reactor pressure	= 5.56×10^5 N/m^2
Jacket pressure	= 3.56×10^5 N/m^2
Jacket length	= 2.55 m
Temperature	= 145^0C
Jacket internal diameter	= 2.27 m
Vessel shell intend diameter	= 2.14 m
Poisson's ratio	= 0.31
Modulus of elasticity	= 192 kN/m^2
Allow stress for moe	= 99 N/m^2

SECTION - II

Q.5 **a)** Draw schematic of compressor knockout drums. State its design for temperature and pressure. **(05)**

b) Draw schematic of actual distillation column with down comer, feed, distillate and bottom product outlet. Draw graph showing operating window for distillation. **(05)**

c) State safety devices in chemical industry. **(04)**

Q.6 **a)** Methanol-water 50 % (mole) mixture to be separated into distillation column to get 95 % (mole) methanol in top product leaving 5 % (mole) methanol in bottom product. If relative volatility is 1.9. How many numbers of plates would be sufficient for said separation, if column is operated at total reflux? **(07)**

b) How heat and mass transfer on every plate achieve purification as unit in distillation column? Explain with schematic and equation on every plate. **(06)**

Q.7 **a)** Crude oil is to be separated from water coming from oil well using decanter. Oil is in dispersed phase while water is in continuous phase. **(09)**
Oil flowrate is 0.278 kg/sec., sp. gr. Oil 0.9, oil viscosity 3 mNs/m^2 . Water flowrate is 83.33 kg/min, sp. gr. = 1, viscosity = 1 mNs/m^2 .
Droplet diameter = 150 μm.
What would be diameter of decanter, residence time of droplet, velocity of oil phase and entrained droplet size.

b) Describe any one gas liquid separator. **(04)**

Q.8. **a)** How do you find time required for drying in rotary dry? State with mathematical expression. **(05)**

b) Ammonia + air mixture obtain from fertilizer plant is to be passed through packed tower with counter water flow. **(08)**
Gas inlet contains 11.2 % NH_3 , 99 % of NH_3 recovery is expected.
equilibrium relation is :

$Y = 15.4\ X$

$$Y = \frac{kg\ NH_3}{kg\ air} \qquad X = \frac{kg\ NH_3}{kg\ water}$$

Water to gas rate is kept 30 % more than minimum value. What should be height of tower? $(HTU)_{OG}$ can be assumed 1 meter.

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